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USE OF FELDSPARS IN THE PRODUCTION OF COLORLESS CONTAINER GLASS

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A feldspar material is proposed as a replacement for alumina in the production of colorless container glass. Positive results were obtained at the Bun'kovskii Experimental Works using ESF501CGG Turkish feldspar.

In the glass industry, complex and readily available initial materials — aluminosilicate alkaline rocks — are used to introduce aluminum oxide into glass. Included among these materials are feldspars, nephelines, pegmatites, and others. Ordinarily, they are used to manufacture the most massive products — glass containers and sheet glass. In addition, Al_2O_3 is introduced in adequate quantities into electrotechnical, chemical-laboratory, thermometric, and other types of glass. As a rule, rocks are distinguished by varying chemical composition and quite substantial content of iron oxides, as a result of which mainly ground, enriched, and neutralized rocks (concentrates) with a moderate content of iron oxides are used in the domestic glass industry. The composition of feldspars is (%[2]): 60 – 70 SiO_2, 15 – 20 Al_2O_3, 0.1 – 3 Fe_2O_3, 0.2 – 1.7 CaO, 0.1 – 0.8 MgO, 3.5 – 10.5 Na_2O, 4 – 8 K_2O, and 0.15 – 1.5 other. Domestic feldspar concentrates are used to introduce Al_2O_3 into green and amber glass used for bottles. Ordinarily, Al_2O_3 is introduced into domestically produced container glass via commercial-grade alumina. As an initial material, feldspar concentrates are less expensive than alumina, even though the quantities of feldspars introduced are larger [1 – 3].

The introduction of aluminum into glass increases the softening temperature of the glass and decreases the CLTE of the glass thereby increasing its heat-resistance, decreases the propensity of glass for undergoing crystallization and thereby stabilizes the glassy state, increases the chemical stability of the glass, and somewhat improves its mechanical properties. At the same time Al_2O_3 increases the viscosity and surface tension of the glass, but this becomes noticeable for Al_2O_3 content above 3%. This makes it necessary to adjust the regimes used to make glass and shape articles [1, 2].

When Al_2O_3 is introduced by means of feldspar concentrates, appreciable amounts of SiO_2, Fe_2O_3, and Na_2O (K_2O) also enter the glass. As a result, the consumption of sand and calcined soda decreases somewhat. In addition, when feldspars of the plagioclase group are used, a small amount of K_2O enters the glass; this not only increases the chemical resistance of the glass as a result of the "two alkali effect" but it also improves its manufacturing characteristics.

One of the most important quality indicators of colorless glass used for containers is the absence any appreciable color tones which appear as a result of coloring by iron oxide impurities present in the initial materials. The main source of iron oxides which enter the glass is sand, by means of which 69 – 72% SiO_2 is introduced. At the present time, enriched glass sands used for manufacturing colorless glass containers contains 0.025 – 0.030% Fe_2O_3. Glass acquires noticeable color tones as a result of Fe_2O_3 contributed by other initial materials (for example, local sands containing up to 0.1% Fe_2O_3) and from contacts with metallic and refractory materials during mix formation and making of the glass. In such cases, it is necessary to introduce larger quantities of discoloring agents which decrease the light transmission and impart a grayish tone to the glass.

Although the commercial-grade alumina used for making glass contains virtually no iron oxides, the initial materials can be utilized more effectively by using pure rock, specifically, feldspar, concentrates. Torgovyi Dom "Gerkules" JSC proposed at the "World of Glass 2006" exhibition using pure and comparatively inexpensive feldspar, obtained from Turkey, to manufacture colorless container glass.

The main characteristics of ESF501CGG Turkish feldspar (according to the quality certificate), proposed for use in the glass industry, are as follows

[1] Torgovyi Dom "Gerkules" JSC, Russia.

[2] Here and below — content by weight.

Chemical Composition

Oxides	Content, %
SiO_2	69.0 (± 1.00)
Al_2O_3	18.50 (± 0.50)
Fe_2O_3	0.02 (± 0.003)
TiO_2	0.03 (± 0.01)
CaO	0.30 (± 0.10)
MgO	0.20 (± 0.10)
K_2O	0.30 (± 0.10)
Na_2O	10.50 (± 0.30)
Other	0.30 (± 0.20)

Granulometric Composition

Fraction, μm	Content, %
> 800	–
> 500	–
> 300	9.00
> 200	22.50
> 100	40.00
> 74	15.00
< 74	15.00 (maximum)

The maximum moisture content of feldspar is no more than 0.1%.

Even though about five times more feldspar than alumina is required (per 1 ton Al_2O_3), the expenditures on initial materials decrease. In addition, an appreciable amount of SiO_2 and Na_2O enters the glass together with the feldspar, so that the consumption of sand and soda decreases. Thus, the yearly savings on initial materials when pure feldspar concentrate is used are easily calculated.

The Bunkovskii Experimental Works (Moscow Oblast') was the first glass works in Russia to use feldspar instead of alumina. The substitution of feldspar for alumina at this enterprise was done gradually with close observation of the glass making process. No complications were observed. A large savings of money and initial materials was obtained; the quality of the glass remained the same. Several enterprises in the Moscow and Vladimir Oblast's have now switched to pure feldspar concentrate. A user dump, from which the feldspar can be removed by truck, has now been organized in Moscow Oblast'.

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